

10/4/2017

lec

دروس هيا مبرور

* Radiation resistance R_{rad}

$$R_{rad} = \frac{W_{rad}}{I_{rms}^2} = 20 \pi^2 \left(\frac{L}{\lambda} \right)^2 \Omega$$

$$R_{rad, mono} = \frac{R_{rad}}{2} = 10 \pi^2 \left(\frac{L}{\lambda} \right)^2 \Omega$$

* Radiation intensity

$$U = r^2 \cdot \bar{P}_{av} = \frac{1}{2\eta} \frac{\omega^2 M^2}{(4\pi)^2} \frac{I_0^2 L^2}{4} \sin^2 \theta \quad \text{W/str}$$

$$U_{max} = \frac{1}{2\eta} \frac{\omega^2 M^2}{(4\pi)^2} \frac{I_0^2 L^2}{4} \quad \text{W/str}$$

* Directivity

الشد العبر ζ_B

$$D = 4\pi \frac{U_{max}}{W_{rad}} = 4\pi \frac{1}{2\eta} \frac{\omega^2 M^2}{16\pi^2} \frac{I_0^2 L^2}{4} \times \frac{\lambda^2}{10\pi^2 I_0^2 L^2}$$

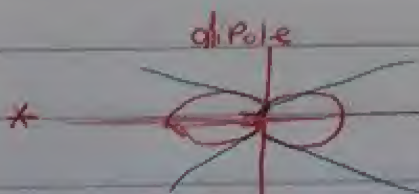
$$= \frac{\zeta^2 B^2}{2\eta} \frac{1}{16\pi} \frac{\lambda^2}{10\pi^2}$$

$$\omega M = \zeta B$$

$$B = \frac{2\pi}{\lambda}$$

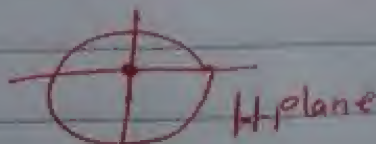
$$= \frac{120\pi}{2} \times \frac{4\pi}{\lambda^2} \frac{1}{16\pi} \frac{\lambda^2}{10\pi^2} = \frac{120 \times 4}{2 \times 16 \times 10} \quad \zeta = 120 \frac{\lambda}{\pi}$$

$$= 1.5$$



$$D = 1.5$$

E-plane



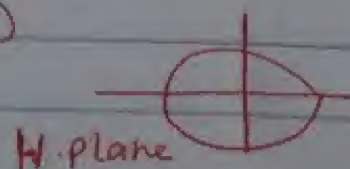
H-plane



Monopole

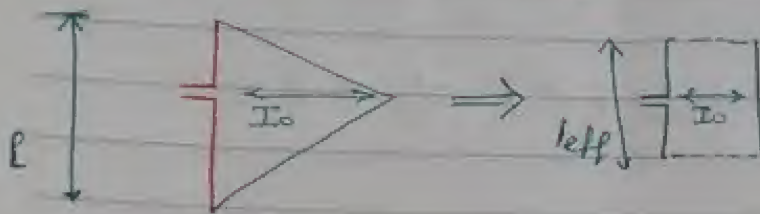
$$D_{mono} = 1.5 \times 2$$

$$D = 3$$



H-plane

* effective length l_{eff}



دipole البسيط

$$\frac{1}{2} l I_0 = l_{eff} I_0$$

$$l_{eff} = \frac{l}{2}$$

dipole

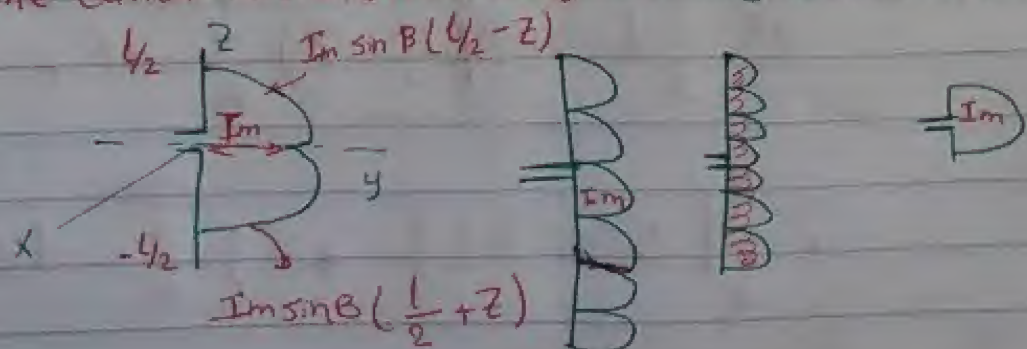
Mono Pole

$$l_{eff}^{mono} = \frac{l}{4}$$

long Dipole

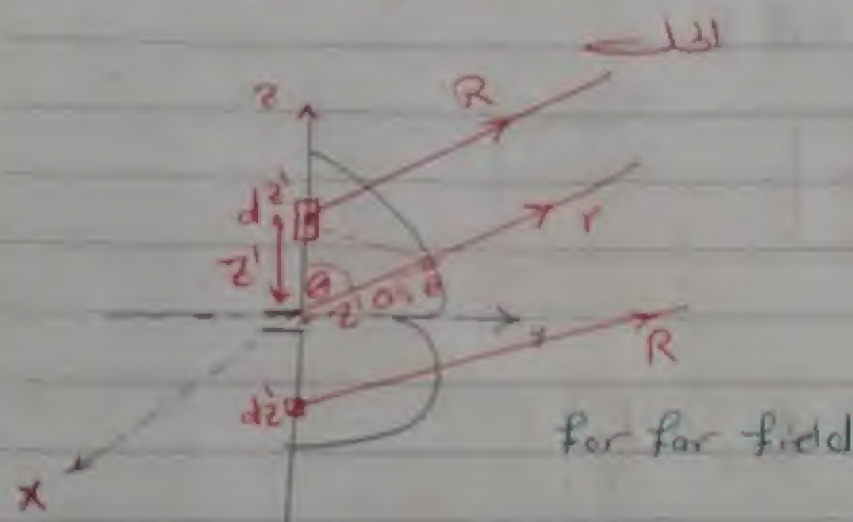
* The wire antenna (dipole) are considered as open ends Transmission lines standing wave patterns along the antenna length.

* The Current Distribution along the long dipole is given by



$$I(z') = \begin{cases} I_m \sin B \left(\frac{L}{2} - z' \right) & 0 < z' < \frac{L}{2} \\ I_m \sin B \left(\frac{L}{2} + z' \right) & -\frac{L}{2} < z' < 0 \end{cases}$$

* Determine the Magnetic Potential Vector for long dipole



$$* \frac{1}{R} \approx \frac{1}{r}$$

$$* R \approx r - z' \cos \theta$$

$$A(x, y, z) = \frac{\mu}{4\pi} \int_{-L/2}^{L/2} I(z') \frac{e^{-jBR}}{R} dz'$$

$$A(x, y, z) = \frac{\mu}{4\pi} \left[\int_0^{L/2} I_m \sin B \left(\frac{L}{2} - z' \right) \frac{e^{-jBR}}{R} dz' + \int_{-L/2}^0 I_m \sin B \left(\frac{L}{2} + z' \right) \frac{e^{-jBR}}{R} dz' \right]$$

$$A(x, y, z) = \frac{M I_m}{4\pi} \left[\int_0^{l/2} \sin B \left(\frac{l}{2} - z' \right) \frac{e^{-jB(r-z'\cos\theta)}}{r} dz' + \int_{-l/2}^0 \sin B \left(\frac{l}{2} + z' \right) \frac{e^{-jB(r-z'\cos\theta)}}{r} dz' \right]$$

↓ دمج الحدود تحت علامة التكامل

$$A_z = \frac{M I_m}{B}$$

يعني

$$A_z = \frac{M}{2\pi} \frac{I_m}{B} \frac{e^{-jBr}}{r} \left[\frac{\cos\left(\frac{Bl}{2}\cos\theta\right) - \cos\frac{Bl}{2}}{\sin^2\theta} \right]$$

$$\textcircled{1} E_\theta = j\omega A_z \sin\theta$$

$$= \frac{j\omega M}{2\pi} \frac{I_m}{B} \frac{e^{-jBr}}{r} \left[\frac{\cos\left(\frac{Bl}{2}\cos\theta\right) - \cos\frac{Bl}{2}}{\sin\theta} \right]$$

$$E_\theta = j \frac{120\pi}{2\pi} \frac{I_m}{B} \frac{e^{-jBr}}{r} \left[\right]$$

$$E_\theta = j 60 I_m \frac{e^{-jBr}}{r} \left[\right]$$

$$|E_\theta| = 60 \frac{I_m}{r} \left[\frac{\cos\left(\frac{Bl}{2}\cos\theta\right) - \cos\frac{Bl}{2}}{\sin\theta} \right]$$

long d.p.a.e. \Rightarrow دالة المجال في الزاوية θ \Rightarrow دالة المجال في الزاوية θ

Special Case $\frac{\lambda}{2}$ dipole and $\frac{\lambda}{2}$ Monopole

$$* L = \frac{\lambda}{2} \text{ dipole}$$

Sub in ①

$$\frac{BL}{2} = \frac{2\pi}{\lambda} \cdot \frac{1}{2} \cdot \frac{\lambda}{2} = \frac{\pi}{2}$$

$$\cos\left(\frac{BL}{2}\right) = \cos\left(\frac{\pi}{2}\right) = 0$$

$$|E_{\theta}| = 60 \frac{I_m}{r} \left[\frac{\cos\left(\frac{\pi}{2} \cos \theta\right)}{\sin \theta} \right] \quad \#$$

$$|H_{\phi}| = \frac{1}{\eta} |E_{\theta}|$$

$$|H_{\phi}| = 60 \frac{I_m}{\eta r} \left[\frac{\cos\left(\frac{\pi}{2} \cos \theta\right)}{\sin \theta} \right] \quad \#$$

$$\bar{P}_{av} = \frac{1}{2\eta} |E_{\theta}|^2 = \frac{1}{2\eta} 60^2 \frac{I_m^2}{r^2} \left[\frac{\cos\left(\frac{\pi}{2} \cos \theta\right)}{\sin \theta} \right]^2 \text{ W/m}^2$$

$$\bar{P}_{av} = \frac{15}{\pi} \frac{I_m^2}{r^2} \left[\frac{\cos\left(\frac{\pi}{2} \cos \theta\right)}{\sin \theta} \right]^2 \text{ W/m}^2 \quad \#$$

$$W_{rad} = \int_0^{2\pi} \int_0^{\pi} \bar{P}_{av} \cdot r^2 \sin \theta \, d\theta \, d\phi$$

$$W_{rad} = \int_0^{2\pi} \int_0^{\pi} \frac{15}{\pi} I_m^2 \left(\frac{\cos \frac{\pi}{2} \cos \theta}{\sin \theta} \right)^2 d\theta d\phi$$

$$W_{rad} = 2\pi \frac{15}{\pi} I_m^2 \int_0^{\pi} \frac{\cos \frac{\pi}{2} \cos \theta}{\sin \theta} d\theta \rightarrow 1.2186$$

$$\therefore W_{rad} = 30 \times 1.2186 I_m^2$$

$$W_{rad} = 36.558 I_m^2$$

$$Watt \Rightarrow R_{rad} = \frac{W_{rad}}{I_{rms}^2}$$

$$W_{rad} = \frac{36.558 I_m^2}{2}$$

سوال البتة في نص السؤال
Directivity

Peak value

$$2 I_{rms}^2$$

$$I_{rms}^2 = \frac{I_m^2}{2}$$

$$R_{rad} = \frac{36.558 \times I_m^2}{I_m^2 / 2} = 2 \times 36.558 = 73 \Omega$$

Pure resistance G

$$R_{rad} = 73 \Omega$$

$$R_{rad} = 36.558 \Omega$$

Directivity

$$D = 4\pi \frac{U_{max}}{W_{rad}}$$

$$U = r^2 \bar{P}_{av} = \frac{15}{\pi} I_m^2 \left[\frac{\cos(\frac{\pi}{2} \cos \theta)}{\sin \theta} \right]^2$$

$$U_{max} = \frac{15}{\pi} I_m^2$$

$$D = 4\pi \frac{15}{\pi} \frac{I_m^2}{36.558 I_m^2}$$

$$D = \frac{4 \times 15}{36.558} = 1.64$$

$$D = 1.64$$

$$D_{long} > D_{short, infinitesimal}$$

as the antenna length
or area increase, the directivity increase

كلما زادت المساحة يزداد D كلما ال D تزداد

$$D_{Monopole} = 2 \times D = 3.28$$

$$D_{Monopole} = 3.28 \quad \#$$